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## **An Analysis of Freshwater Mussels (Unionidae) Along Luxapalila Creek, Mississippi, 1999 Studies**

Andrew C. Miller

September 2001

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Final report

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# Preface

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In October 1999, a survey for freshwater mussels was conducted along Luxapalila Creek, Mississippi, between Steens, Mississippi, and Waterworks Road Bridge, River Mile 6.2. The purpose was to obtain information that could be used to assess the effectiveness of reasonable and prudent measures and their terms and conditions to reduce impacts to mussels caused by downstream channelization. In addition, results would be used to determine the likelihood of future losses, or incidental take, of federally listed species in the project area. Studies were conducted by the U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory (EL). Staff members from the ERDC conducted similar studies for mussels in 1997 and 1998.

This report was prepared by Dr. Andrew C. Miller, Aquatic Ecology Branch (AEB), Ecological Research Division (ERD), EL, ERDC.

Assistance in the field was provided by: Messrs. Larry Neill, Rob James, Johnny Buchanan, the Tennessee Valley Authority, as well as Mr. Will Green, University of Southern Mississippi. Mr. Brian Peck, U.S. Army Engineer District, Mobile (Planning and Environmental Division), provided maps and other background information.

During the conduct of this study, Dr. Edwin A. Theriot was Acting Director, EL; Dr. Conrad J. Kirby was Chief, ERD, and Dr. Alfred F. Cofrancesco, was Chief, AEB, ERDC.

During the publication of this report, Dr. James R. Houston was Director, ERDC, and COL John W. Morris III, EN, was Commander and Executive Director.

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# 1 Introduction

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## Background

Channelization and widening of the Columbus reach of Luxapalila Creek, located in east-central Mississippi, began in September 1994. Work started at River Mile (RM) 2.1, moved upriver until December of that year, and then resumed in June 1995. Work continued through December 1995 when high flow prevented completion of the final 0.37 km (0.2 miles) of the upper Columbus reach. The final 0.37 km (0.2 miles), up to RM 6.0, was completed in 1996. During this period, the reach immediately upriver of Waterworks Road Bridge (RM 6.2) was unprotected from higher water velocities and decreased water surface elevations that resulted from the increased slope and drainage efficiency of the downstream reach. On 15 March 1996, the U.S. Fish and Wildlife Service (USFWS) contacted the U.S. Army Engineer District, Mobile (CESAM), about Luxapalila Creek. They had received information from the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), concerning degradation upriver of Waterworks Road Bridge. A site visit revealed stream bank erosion and undercutting, bank failure with fallen trees, increased water velocities, decreased water surface elevations, recent gravel bar reworking and deposition, scoured water willow beds, and significant shifts in channel thalweg (USFWS 1996). Field investigations by the MDWFP indicated that the effects of channel instability were continuing and were evident at least up to RM 8.2 (per Mr. Charles Watts as cited by USFWS 1996). These observations suggested that significant channel degradation and erosion had recently occurred in response, at least in part, to the downstream channelization between RM 2.1 and 6.0.

The project area is within the range of the following federally listed endemic mussels: *Pleurobema perovatum* (ovate clubshell mussel) and *Pleurobema decisum* (southern clubshell mussel), listed as endangered; and *Medionidus acutissimus* (Alabama moccasinshell mussel) and *Lampsilis perovalis* (orange-nacre mucket mussel) listed as threatened. These species originally occurred widely in the Tombigbee River drainage, including the Tombigbee River and some of its larger tributaries. These riverine species inhabit high quality, stable gravel or gravelly sands with flowing water.

At the request of the CESAM, the USFWS prepared a Biological Opinion which provided Reasonable and Prudent Measures (RPMs) and their terms and conditions (T&C) to avoid or minimize incidental 'take' of federally listed mussel species. Among the RPMs and their T&C to be implemented by the CESAM was

the monitoring of mussel populations upstream from Waterworks Road Bridge. Results of this monitoring, in conjunction with hydrologic monitoring at selected cross section stations to be conducted by CESAM, would be used to assess the effectiveness of RPMs and their T&C to reduce impacts to mussels. Results will also be used to determine the likelihood of future losses or incidental take of federally listed species.

The first published list of mussels in Luxapalila Creek was by C.A. Schultz (1981). In addition to reporting on fishes in the Tombigbee River before construction of the Tennessee-Tombigbee Waterway, Mr. Shultz listed freshwater mussels from the entire basin including 13 species from Luxapalila Creek. Personnel from the Mississippi Museum of Natural Science collected mussels in Luxapalila Creek in the 1980s and early 1990s (Hartfield and Bowker 1992).

On 19 August 1997, ten sites between RM 14.6 and 10.1 were searched for mussels by waders and divers using mainly qualitative methods. Specific searches for juvenile mussels were also made by collecting total substratum samples and sieving sediments. On 1 September 1998 the survey was repeated, using nearly the same methods. During 1998, however, divers were not used, since the majority of the mussels were collected by waders in shallow water. In addition, an 11th sample site was added in the 1998 survey. The 1997 and 1998 surveys are reported by Miller (1998) and herein.

On 20 and 21 October 1999, the survey was repeated using only waders and no divers. A total of 14 sites were searched. Previously samples sites were surveyed again, plus three new sites.

## **Purpose and Scope**

The purpose was to collect information on mussels in Luxapalila Creek upstream of Waterworks Road Bridge to evaluate effects of recent channel modifications and project-induced water velocity changes.

## 2 Study Area and Methods

### Study Area

Luxapalila Creek begins as three small creeks in western Alabama near the border of Lamar and Pickens counties (Figure 1). The creeks flow west into Mississippi to form Luxapalila Creek in eastern Lowndes county which then joins Yellow Creek, west of Steens, Mississippi. Luxapalila Creek then flows southwest through Columbus where it enters the Tombigbee River. The project area begins near Steens and continues to Waterworks Road Bridge, a distance of approximately 13 km (7 miles) (Figure 1).

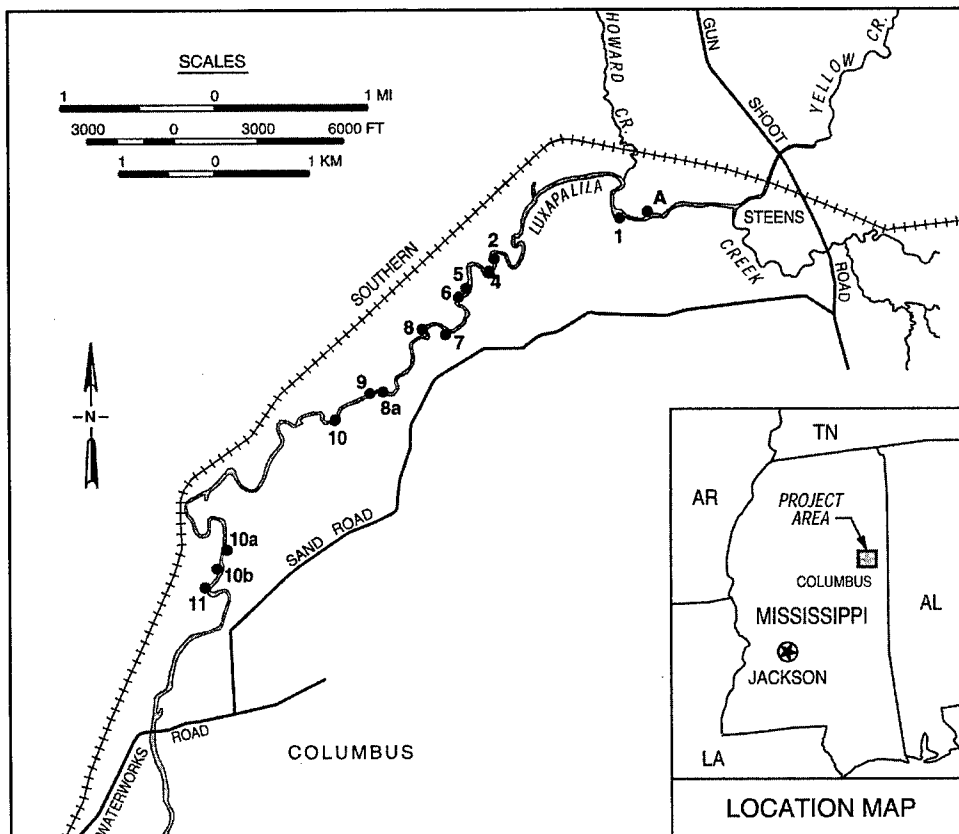


Figure 1. Map of the study area

Between Steens and the confluence of Yellow Creek, Luxapalila Creek was narrow with steep banks (1 to 2 m) and sharp bends. There were no exposed shoals and current velocity ranged between 25 and 50 cm/sec (10 and 20 in./sec). Between the confluence of Yellow Creek and just downriver of the last site sampled, the creek consisted of a sequence of long, narrow pools, runs, and riffles. During the time of the survey, water velocity ranged between 25 and 50 cm/sec (10 and 20 in./sec), and the habitat consisted of shallow runs, riffles, and exposed bars. Between the last site sampled and Waterworks Road Bridge, there were fewer exposed gravel shoals, the water was deeper, and velocity was approximately 75 cm/sec (30 in./sec).

## Methods

Mussels were collected at 14 sites between RM 14.6 and 8.0 (Tables 1 and 2, Figure 1). Sites were identified based upon a reconnaissance of the study area conducted with personnel from the CESAM and USFWS on 14 November 1996 (Miller 1998). Stage height during the first survey, 19 August 1997, was 1.98 m (6.5 ft), and on 1 September 1998 it was 1.77 m (5.80 ft). On 20 October 1999 stage height was 1.58 m (5.17 ft).

All collectors worked and searched for mussels for specific time periods, usually 30 min. They moved on their hands and knees, and collected all live bivalves encountered by touch. Depending on conditions and personal preferences, some collectors used rakes to help search the substratum. In addition and at each site, two to three quantitative, total substratum samples were obtained, and sediments were wet-sieved through a screen series and carefully examined for live juveniles. However, more tedious, total substratum sampling is more likely to obtain live juveniles than qualitative collecting by hand. Total area of bottom sampled quantitatively is listed in Table 2. Virtually the same methods employed in 1997 and 1998 were used in 1999.

At the end of the collecting period, mussels and shells from each site were counted and identified. Representative shells of each species were retained for voucher; most live organisms were returned to the river unharmed. Specimens were compared with shells in the reference collection at the Mississippi Museum of Natural Science. More information on methods for sampling can be found in Isom and Gooch (1986); Kovalak, Dennis, and Bates (1986); Miller and Payne (1988); and, Miller et al. (1993). Mussel taxonomy is consistent with Williams et al. (1993).

## 3 Results and Discussion

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### Characterization of the Mussel Resource

A total of 128 freshwater mussels, representing 15 species including *Corbicula fluminea* (Asian clam), was collected during the survey in 1999 (Tables 3 through 6). Total search time expended was 930 min (15.5 hr) and ranged from 30 min at Site 11 to 90 min at most other sites (Table 3). The greatest number of mussels collected per minute was at Site 6 (0.61/min) where eight species were collected. The site with the next most abundant fauna was number 10A, where seven species were collected and 0.36 individuals were collected per minute. At six sites, 15 or less live mussels were collected, and at three sites no live mussels were collected (Table 3). A total of 128 live mussels were collected in 1999. Mussel collecting rates ranged from 0.02 to 0.61 individuals/min; with a mean rate 0.14 individuals/min (Table 3). This value for 1999 was virtually the same rate that mussels were collected in 1998. However, both values were approximately 50 percent greater than the overall collecting rate for 1997.

Using similar techniques, divers have collected up to eight mussels/min in moderate- to high-density beds in the upper Mississippi River, Wisconsin (Miller and Payne 1996), and in the Sunflower River, central Mississippi (Miller and Payne 1995). Density in the majority of these sites along Luxapalila Creek, when compared with medium-sized to large rivers in the central and southeastern United States, is moderate to low. Based upon the results of quantitative sampling, no juvenile mussels were found at most sites. However, very small *Quadrula asperata* (Alabama orb) were found at Site 6. These specimens were less than 15 mm and evidence of recruitment probably in early 1999, although possibly in 1998. It is very likely that recruitment is occurring for most species in the Luxapalila Creek; however, the number of juveniles is so low that it is difficult to find them.

Based upon living specimens, the most abundant species were: *Quadrula asperata* and *Lampsilis straminea claibornensis* (southern fatmucket) which comprised 31.2 and 19.5 percent of the fauna (Table 3). Both species are relatively common in sand gravel substratum in southern streams. The third and fourth most abundant species, *Tritogonia verrucosa* (pistolgrip) and *Lampsilis ornata* (southern pocketbook), each comprised 18.7 and 10.9 percent of the collection. Both species are common in fine-grained sands and silt in lentic or

lotic habitats in Mississippi. The remaining 11 species each comprised less than 4 percent of the bivalve fauna.

Hartfield and Bowker (1992) searched for bivalves along Luxapalila Creek on 11 and 12 May 1992. Stage height was at 2.29 m (7.5 ft) during both days. Collections were made by hand; no diving was done. Sampling methods used during both surveys are approximately similar; no divers were used. Hartfield and Bowker (1992) reported on live mussels from the following reaches (moving downriver):

- a. Reach 1 – Distance from Steens to the entrance of Yellow Creek
- b. Reach 2 – Distance from the entrance of Yellow Creek to the mouth of Howard Creek
- c. Reach 3 – Distance from the mouth of Howard Creek to the center of section 30 (near our Site 1, Figure 1)
- d. Reach 4 – Distance from section 30 through section 36 (downriver of Site 11, Figure 1).

In addition to *C. fluminea*, they collected 11 species of freshwater mussels and 72 individuals (Table 5). Based upon results of their studies and historical information, Hartfield and Bowker (1992) listed 21 species of mussels from Luxapalila Creek. Their list included four previously unreported species: *Elliptio arca* (Alabama spike), *Fusconaia cerina* (Gulf pigtoe), *Potamilus purpuratus* (bleufer), and *Megaloniaias nervosa* (washboard). Of these four previously unreported species, only *F. cerina* was taken alive; the remainder were collected as shells.

When results of 1997, 1998, and 1999 surveys are combined, 22 species of mussels have been collected alive in Luxapalila Creek. Seven species, *Anodonta suborbiculata* (flat floater), *Lasmigonia complanata* (white heelsplitter), *Obovaria unicolor* (Alabama hickorynut), *Pyganodon grandis*, (giant floater), *Leptodea fragilis* (papershell), and *Quadrula rumphiana* (ridged mapleleaf), have not been reported previously from the project area. These species were missed during previous surveys, or they may have been recently introduced. When information from our surveys are combined with information reported by Hartfield and Bowker (1992), the total number of freshwater mussels from Luxapalila Creek is now 27, not counting *C. fluminea* (Table 6).

## Summary Information on Conditions at Specific Sites Along Luxapalila Creek

**Site A.** We searched for mussels a total of approximately 90 min at an exposed gravel bar 500 m (1,640 ft) upriver of Site 1 (Figure 1). This site was not searched in previous years. No live mussels were collected.

**Site 1.** In the last 3 years, no more than two species or more than five live mussels have been found at any one time of collecting in a year (Appendix A,

Table A1). This is a low-density site, and physical conditions have remained the same each year.

**Site 2.** We found fewer mussels at Site 2 in 1999 than we did during the previous 2 years (Table A1). A total of 17 species have been found at this site, and in the first two survey years more than 50 mussels were collected. It is possible that extreme low water in 1999 exposed live mussels to predation. Physical conditions at this location have not changed since 1997, with the exception of the extreme low water during 1999.

**Site 3.** As noted in Tables 1, 2, and A2, this site was not worked in 1999 because of extreme low water. Only *C. fluminea* was found here in the past (Table A2).

**Site 4.** Eight species were collected at this location in 1998; six were taken in 1999. Conditions at this site have remained similar each year. A total of 10 species have been collected at this site since we began work on this creek (Table A2).

**Site 5.** Progressively more species and individuals have been collected at this site each year since this work was begun. In 1997, one species was found, and in 1999, five species and 10 live mussels were collected. A total of seven species have been collected at this site during the three survey years (Table A3).

**Site 6.** More live mussels were taken in 1999 (55 live and 8 different species) than in the two previous years combined. In addition, evidence of recent recruitment (individuals less than the 15-mm total shell length) was found for *Q. asperata*. Nine species have been taken here in the last 3 years of sampling (Table A3).

**Site 7.** This has never been a productive site for mussels. Two individuals and species were collected in 1998; none were taken in 1997 and 1999 (Table A4).

**Site 8.** Five live mussels and two species were taken in 1999 and 1997, although no live mussels were found at this location in 1998. This site, like Site 7, has never had many mussels present (Table A4).

**Site 8a.** 45-min period was spent searching at an exposed gravel bar upriver of Site 9 (Figure 1). No live mussels or shells were found at this location. This site had not been surveyed in previous years.

**Site 9.** This has never been a productive location for mussels. Three species were found in 1999 and 1997; a single live species was collected in 1998. A total of four species have been taken at this location (Table A5).

**Site 10.** Progressively fewer species and live mussels have been collected each year at this location since 1997 (Table A5). Part of the reason for this may be reduced water levels at a slough where the majority of the mussels were taken in 1997. Low water in the slough appeared to be mainly the result of reduced

water levels in Luxapalila Creek and a tributary stream that feeds the slough. Thirteen species have been taken at this location since 1997.

**Site 10a.** This site was first surveyed in 1999. A total of 7 species and 16 live mussels were collected in 1999 (Table A6). This is a stable shoal with many depositional areas along the left descending bank where mussels can be found.

**Site 10b.** This site was first surveyed in 1999. No living mussels were collected at this location (Table A6).

**Site 11.** This site was first surveyed in 1998. No live mussels were collected in 1998 or 1999 at this location (Table A7).

## **Effects of Channel Modifications on Water Velocity**

The HEC-2 Model was used to evaluate the effects of completed channel modifications downstream of Waterworks Road Bridge on water velocity (see following text). Differences between pre- and postproject water velocities were least (3 cm/sec (<0.1 ft/s)) at low discharge and greatest (10.7 cm/s (>0.35 ft/s)) at high discharge. Mean water velocity values were highest at the downstream portion of the study area. At RM 6.11 and 7.18, mean velocity differences between pre- and postproject conditions were greater than 15.2 cm/sec (0.5 ft/sec). At the most upstream river reaches, differences between pre- and postproject water velocity approached 0.

The majority of mussel species collected in the 1992 survey by Hartfield and Bowker (1992), and the three surveys conducted by the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg site, were taken between RM 10.1 and 14.3. This reach is approximately 6.45 km (4 miles) upriver from the reach near Waterworks Road Bridge, where bank failure and erosion took place. When results of the 1992 survey are compared with data from 1997 through 1999, it appears that so far at least, project-induced velocity changes have had virtually no effect on total numbers of species present (Figure 2).

However, it is always possible that impacts of slightly increased velocity, the result of downstream channel modifications, will not be measurable in this river reach for years. For example, water release schedules from Wolf Creek Dam, Tennessee, completed in 1952, eliminated mussel recruitment in the lower Cumberland River. Although unionid recruitment ceased, living adult mussels were collected in the affected reach as late as 1982 (Miller, Rhodes, and Tippit 1984).

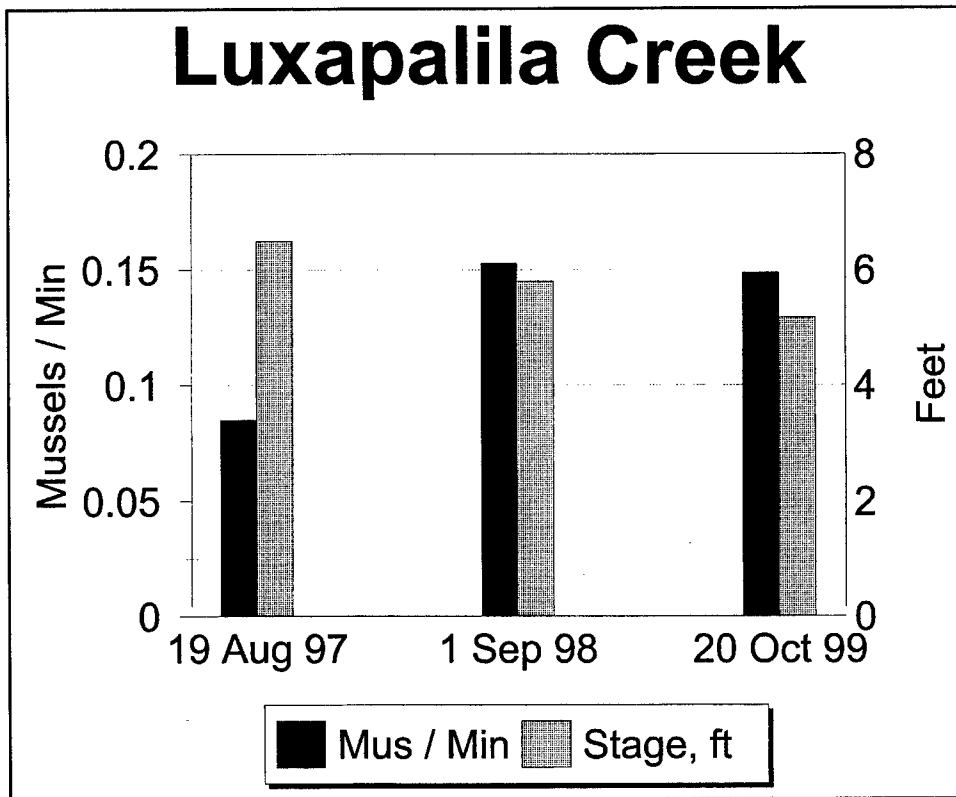


Figure 2. Collection rate (mussels/min) and stage height at Steens, Mississippi, when surveys were conducted, Luxapalila Creek, 1997-1999

### Effects of River Stage on Collecting Rate

Mussel collecting rate in the Luxapalila Creek is influenced by river stage. In 1997, stage height was 2 m (6.55 ft) and the collecting rate was 0.101 individuals/min (Figure 3). In 1998 stage height was slightly less, 1.77 m (5.80 ft), and collecting rate was nearly 50 percent greater, with 0.150 individuals collected/minute. Collecting rates were relatively similar in 1998 and 1999 (0.15 and 0.149 mussels collected per min, respectively), although stage height in 1999 was less than previous years, 1.58 m (5.17 ft). When Hartfield and Bowker (1992) conducted their survey the stage height was 2.29 m (7.5 ft), somewhat higher than during previous surveys. Although they did not record the collecting rate, it is very likely that it was negatively affected by water level. Collectors become less efficient as the water becomes deeper, the velocity higher, and it is more difficult to obtain live mussels.

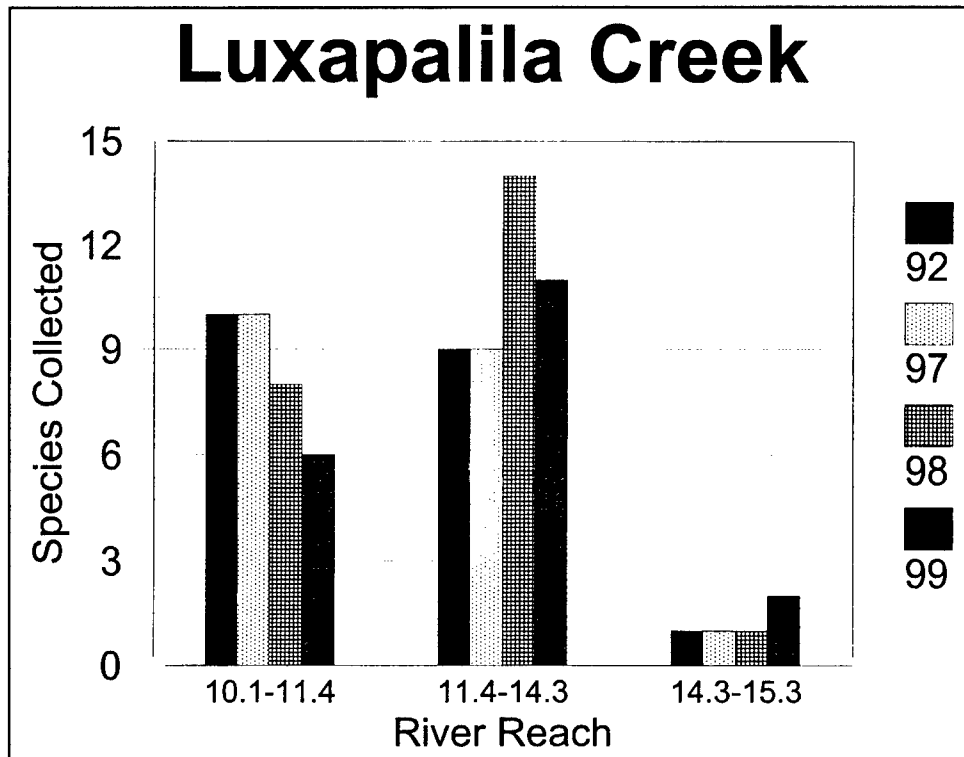


Figure 3. Species richness in Luxapalila Creek based on surveys conducted in 1992 (Hartfield and Bowker 1992) and by personnel of the ERDC in 1997-1999

## Summary and Recommendations

### Characterization of the Mussel Resource

In comparison with other habitats in southern rivers, the mussel fauna of Luxapalila Creek can be described as having moderate to low density. Although shells were commonly found on exposed bars, the number of live mussels found in riffles, runs, or pools was low. Regardless, the total number of mussel species present (27), based upon surveys in 1997 through 1999 as well as that by Hartfield and Bowker (1992), should be considered high for this stream and reflects good water quality and habitat diversity. Typically, larger rivers support greater numbers of mussel species than smaller rivers. The molluscan resource in Luxapalila Creek should be considered valuable because of its high species richness and presence of many uncommon species such as *P. perovatum*, *P. decisum*, and *L. perovalis*. In 1999 recent recruitment for *Q. asperata* was noted. Although juvenile mussels have always been uncommon in this river, successful recruitment each year is not required to sustain a dense and diverse community.

## **Future Studies**

Results of future studies will be important to determine if the altered water velocity is having long-term effects on the mussel fauna. Based on data collected in 1992, 1997, 1998, and 1999, the number of species present has remained essentially unchanged (Figure 2).

Most species collected during these surveys can live to be 20 or more years old. Therefore, results of future studies can be used to determine if present stocks are successfully recruiting. If the same sampling protocol is used (i.e., timed searches), then results can be compared with data collected during the 1997 through 1999 surveys.

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**Table 1**  
**Global Positioning System Coordinates, Luxapalila Creek,**  
**Mississippi, 1999**

WayPoint	Site	Notes	Latitude (N)	Longitude (W)
1	A	New in 1999	33.56445	88.33603
2	1		33.564413	88.33948
3	2		33.560421	88.35434
ND	3	Dry in 1999		
4	4		33.558925	88.35477
5	5		33.556978	88.35761
6	6		33.556519	88.35841
7	7		33.552997	88.36036
8	8		33.553308	88.36271
9	9		33.546925	88.36958
10	10		33.544543	88.37296
11	8A	New in 1999	33.547201	88.36769
12	10B	New in 1999	33.529887	88.38696
13	10A	New in 1999	33.531808	88.38625
14	11	New in 1998	33.528332	88.38846

**Table 2**  
**Field Notes for Sites Surveyed along Luxapalila Creek, Mississippi, 1999**

Way-point	Site	River Mile	Notes
1	A	14.4	Exposed gravel bar on the right descending bank (RDB) of the river. There was a considerable amount of exposed gravel present. This site was not surveyed in previous years. Three quantitative samples were collected.
2	1	14.6	Slough on left descending bank (LDB), and a considerable amount of exposed sand and gravel at the site which was located along a sharp right turn in the river. Shells were found along the shoreline, although only one live mussel was collected. Three quantitative samples were collected.
3	2	12.8	An exposed sand and gravel shoal located along the LDB. Most common thick-shelled live mussels were collected in shallow water immediately upriver of a sharp right turn and embayment with fine sand and silt substratum. Five quantitative samples were collected.
4	4	12.6	This site was along the LDB approximately 100 m (328 ft) upriver of Site 3. The site was along a straight reach of river immediately downriver of a sharp left turn in the river. Three quantitative samples were collected.
5	5	11.9	An exposed gravel shoal along the RDB immediately upriver of a right turn in the river. Not a very productive site for mussels. Three quantitative samples were collected.
6	6	11.7	This consisted of an exposed sand and gravel along the shore, and shallow, moderately high-velocity water (40 cm/sec (16 in./sec)) along the RDB. Three quantitative samples were collected.
7	7	10.9	A shoal along the RDB immediately upriver of a sharp right turn. Three quantitative samples were collected.
8	8	10.5	Exposed gravel shoal along the LDB. This was not a very productive site. Three quantitative samples were collected.
9	9	10.3	Collections were made along either side and immediately upriver of a vegetated gravel shoal located nearly in the center of the river. Not a very productive site. Three quantitative samples were collected.
10	10	10.1	This is an embayment along the LDB where a small stream enters the creek. Three quantitative samples were collected. This is the last site that can be reached from the boat ramp at Steens, Mississippi. The other sites were reached by launching the boats at Waterworks Road Bridge.
11	8a	10.4	This was a gravel shoal along the LDB. No live mussels were collected. No samples were taken at this location in previous years.
12	10a	8.5	This and Site 10B were new for 1999. Mussels were collected along the LDB at the upriver section of a long shoal along both sides of the river.
13	10b	8.3	This was at the downriver section of the shoal that started at Site 10A. Substratum was eroding and no live mussels were collected.
14	11	8	This location appears to be a transitional zone (moving upriver) where effects of the weirs are not apparent. There was moderate to high-velocity water in the riffles and the substratum was erosional. Three quantitative samples were collected.
<p>Note: Site 3, RM 12.7, was in an embayment on the LDB next to a sharp right turn in the river. In previous years, the embayment held water and samples were collected. In 1999, the area was dry and no samples were collected.</p>			

**Table 3**  
**Freshwater Mussels Collected Along Luxapalila Creek, Mississippi, 1999.**

Scientific Name	Site Number												
	1	2	3	4	5	6	7	8	9	10	10a	10b	11
<i>Quadrula asperata</i>	0.00	46.67	0.00	33.33	0.00	40.00	0.00	0.00	0.00	37.50	31.25	0.00	0.00
<i>Lampsilis s. claibomensis</i>	0.00	20.00	0.00	11.11	0.00	21.82	0.00	80.00	33.33	0.00	18.75	0.00	0.00
<i>Tritogonia verrucosa</i>	75.00	0.00	0.00	22.22	50.00	10.91	0.00	0.00	50.00	25.00	18.75	0.00	0.00
<i>Lampsilis ornata</i>	25.00	6.67	0.00	11.11	20.00	10.91	0.00	20.00	0.00	25.00	0.00	0.00	0.00
<i>Fusconaia cerina</i>	0.00	6.67	0.00	11.11	10.00	0.00	0.00	0.00	16.67	0.00	6.25	0.00	0.00
<i>Villosa lienosa</i>	0.00	0.00	0.00	0.00	0.00	7.27	0.00	0.00	0.00	12.50	0.00	0.00	0.00
<i>Toxolasma parva</i>	0.00	6.67	0.00	0.00	0.00	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lampsilis perovalis</i>	0.00	0.00	0.00	11.11	0.00	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Pleurobema decisum</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.50	0.00	0.00
<i>Elliptio crassidens</i>	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	6.25	0.00	0.00
<i>Obovaria jacksoniana</i>	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Quadrula rumphiana</i>	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Potamilus purpuratus</i>	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lampsilis teres</i>	0.00	0.00	0.00	0.00	0.00	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Elliptio arctata</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.25	0.00	0.00
Total individuals	4	15	0	9	10	55	0	5	6	8	16	0	0
Total species	2	7	0	6	5	8	0	2	3	4	7	0	0
Total time (min)	90	90	0	90	90	90	90	90	90	90	45	45	30
Total time (hr)	1.5	1.5	0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.75	0.75	0.5
Individuals/min	0.04	0.17	0.00	0.02	0.11	0.61	0.00	0.06	0.07	0.09	0.36	0.00	0.00

**Table 4**  
**Summary Information on Freshwater Mussels Collected Along Luxapalila Creek,**  
**Mississippi, 1999**

Scientific Name	Common Name	Total	%	Freq	%
<i>Quadrula asperata</i>	Alabama orb	40	31.25	5	38.46
<i>Lampsilis s. claibornensis</i>	Southern fatmucket	25	19.53	6	46.15
<i>Tritogonia verrucosa</i>	Pistolgrip	24	18.75	7	53.85
<i>Lampsilis ornata</i>	Southern pocketbook	14	10.94	7	53.85
<i>Fusconaia cerina</i>	Gulf pigtoe	5	3.91	5	38.46
<i>Villosa lienosa</i>	Little spectaclecase	5	3.91	2	15.38
<i>Toxolasma parva</i>	Lilliput	3	2.34	2	15.38
<i>Lampsilis perovalis</i>	Orange-nacre mucket	3	2.34	2	15.38
<i>Pleurobema decisum</i>	Southern clubshell	2	1.56	1	7.69
<i>Elliptio crassidens</i>	Elephant-ear	2	1.56	2	15.38
<i>Obovaria jacksoniana</i>	Southern hickorynut	1	0.78	1	7.69
<i>Quadrula rumphiana</i>	Ridged mapleleaf	1	0.78	1	7.69
<i>Potamilus purpuratus</i>	Bleufer	1	0.78	1	7.69
<i>Lampsilis teres</i>	Yellow sandshell	1	0.78	1	7.69
<i>Elliptio arctata</i>	Delicate spike	1	0.78	1	7.69
Total individuals		128			
Total species		15			
Total sites		15			
Total time (min)		930			
Individuals/min		0.149			

**Table 5**  
**Percentage Abundance of Freshwater Mussels in Luxapalila Creek, Mississippi, Based**  
**Upon a Survey by Hartfield and Bowker (1992) and Surveys Conducted in 1997-99 by**  
**ERDC. (ND = No data)**

Species	Common Name	Hartfield & Bowker 1992	ERDC Surveys		
			1997	1998	1999
<i>Anodonta suborbiculata</i>	Flat floater		0.86		
<i>Elliptio arctata</i>	Delicate spike			2.11	.78
<i>Elliptio arca</i>	Alabama spike				
<i>Elliptio crassidens</i>	Elephant-ear			0.70	1.56
<i>Fusconaia cerina</i>	Gulf pigtoe	6.94	4.31	2.11	3.91
<i>Lampsilis s. claibornensis</i>	Southern fatmucket	12.5	0.69	11.27	19.53
<i>Lampsilis ornata</i>	Southern pocketbook	16.67	11.21	12.68	10.94
<i>Lampsilis perovalis</i>	Orange-nacre mucket		0.86		2.34
<i>Lampsilis teres</i>	Yellow sandshell		0.86	0.70	0.78
<i>Lasmigonia c. complanata</i>	White heelsplitter		0.86		
<i>Leptodea fragilis</i>	Papershell			0.70	
<i>Medionidus acutissimus</i>	Alabama moccasinshell				
<i>Megaloniaias nervosa</i>	Washboard				
<i>Obovaria jacksoniana</i>	Southern hickorynut	9.72	1.72	1.41	0.78
<i>Obovaria unicolor</i>	Alabama hickorynut		0.86		
<i>Pleurobema decisum</i>	Southern clubshell	1.39		2.11	1.56
<i>Pleurobema perovatum</i>	Ovate clubshell	6.94			
<i>Potamilus purpuratus</i>	Bleufer				0.78
<i>Pyganodon grandis</i>	Giant floater		0.86		
<i>Quadrula asperata</i>	Alabama orb	25	47.41	39.44	31.25
<i>Quadrula rumphiana</i>	Ridged mapleleaf				0.78
<i>Strophitus subvexus</i>	Southern creekmussel	1.39		1.41	
<i>Toxolasma parva</i>	Lilliput			0.7	2.34
<i>Tritogonia verrucosa</i>	Pistolgrip	16.67	6.03	23.94	18.75
<i>Truncilla donaciformis</i>	Fawnsfoot	1.39			
<i>Villosa lienosa</i>	Little spectaclecase		2.59		3.91
<i>Villosa vibex</i>	Southern rainbow	1.39	0.86	0.7	
<b>Total Individuals</b>		72	123	142	128
<b>Total species</b>		11	14	14	15
<b>Individuals collected / min</b>		ND	0.085	0.153	0.149

**Table 6**

**Freshwater Mussels of Luxapalila Creek, 1980 to Present. Column 4, 'Mussels from the area,' was published in Hartfield and Bowker (1992), includes information obtained by Schultz (1981), and historical information, as well as results of recent collections. Although not listed, *C. fluminea* has been collected regularly from Luxapalila Creek at least since 1980 (Schultz 1981). (E = Endangered, T = Threatened)**

Species	Common Name	Schultz 1980	Hartfield & Bowker 1992	Mussels From the Area	ERDC Surveys		
					1997	1998	1999
<i>Anodonta suborbiculata</i>	Flat floater				x		
<i>Elliptio arcata</i>	Delicate spike	x		x		x	x
<i>Elliptio arca</i>	Alabama spike			x			
<i>Elliptio crassidens</i>	Elephant-ear	x		x		x	x
<i>Fusconaia cerina</i>	Gulf pigtoe		x	x	x	x	x
<i>Lampsilis s. claibornensis</i>	Southern fatmucket	x	x	x	x	x	x
<i>Lampsilis ornata</i>	Southern pocketbook	x	x	x	x	x	x
<i>Lampsilis perovalis</i>	Orange-nacre mucket (T)		x	x	x		x
<i>Lampsilis teres</i>	Yellow sandshell	x		x	x	x	x
<i>Lasmigonia c. complanata</i>	White heelsplitter				x		
<i>Leptodea fragilis</i>	Papershell					x	
<i>Medionidus acutissimus</i>	Alabama moccasinshell (T)			x			
<i>Megaloniaias nervosa</i>	Washboard			x			
<i>Obovaria jacksoniana</i>	Southern hickorynut	x	x	x	x	x	x
<i>Obovaria unicolor</i>	Alabama hickorynut				x		
<i>Pleurobema decisum</i>	Southern clubshell (E)	x	x	x		x	x
<i>Pleurobema perovatum</i>	Ovate clubshell (E)	x		x			
<i>Potamilus purpuratus</i>	Bleufer			x			x
<i>Pyganodon grandis</i>	Giant floater				x		
<i>Quadrula asperata</i>	Alabama orb	x	x	x	x	x	x
<i>Quadrula rumphiana</i>	Ridged mapleleaf						x
<i>Strophitus subvexus</i>	Southern creekmussel	x	x	x		x	
<i>Toxolasma parva</i>	Lilliput			x		x	x
<i>Tritogonia verrucosa</i>	Pistolgrip	x	x	x	x	x	x
<i>Truncilla donaciformis</i>	Fawnsfoot		x	x			
<i>Villosa lienosa</i>	Little spectaclecase	x		x	x		x
<i>Villosa vibex</i>	Southern rainbow	x	x	x	x	x	
<b>Total species</b>	<b>27</b>	<b>13</b>	<b>11</b>	<b>21</b>	<b>14</b>	<b>14</b>	<b>15</b>

# Appendix A

## Tables

**Table A1**  
**Summary of 3 Years (1997, 1998, and 1999) of Sampling for Freshwater Bivalves at Sites 1 and 2 on Luxapalila Creek, Mississippi**

Species	Site 1			Site 2		
	1997	1998	1999	1997	1998	1999
<i>Quadrula asperata</i>	1			29	39	7
<i>Lampsilis ornata</i>		1	1	6	7	1
<i>Lampsilis s. claibornensis</i>				13	6	3
<i>Tritogonia verrucosa</i>			3	3	27	
<i>Corbicula fluminea</i>	1			1		
<i>Fusconaia cerina</i>					1	1
<i>Villosa lienosa</i>				2		
<i>Obovaria jacksoniana</i>				1	1	1
<i>Obovaria unicolor</i>				1		
<i>Lampsilis perovalis</i>						
<i>Lampsilis complanata</i>				1		
<i>Villosa vibex</i>					1	
<i>Pyganodon suborbiculata</i>						
<i>Pyganodon grandis</i>						
<i>Lampsilis teres</i>					1	
<i>Elliptio arctata</i>						
<i>Elliptio crassidens</i>						
<i>Leptodea fragilis</i>					1	
<i>Pleurobema decisum</i>					2	
<i>Strophitus subvexus</i>					2	
<i>Toxolasma parva</i>						1
<i>Potamilus purpuratus</i>						1
<i>Quadrula rumphiana</i>						
Total individuals	2	1	4	57	88	15
Total species	2	1	2	9	11	7
Total time (min)	178	106	90	205	101	90
Total time (hr)	3.0	1.8	1.5	3.4	1.7	1.5
Individuals/min	0.011	0.009	0.044	0.278	0.871	0.167

**Table A2**  
**Summary of 3 Years (1997, 1998, and 1999) of Sampling for Freshwater Bivalves at Sites 3 and 4 on Luxapalila Creek, Mississippi**

Species	Site 3			Site 4		
	1997	1998	1999	1997	1998	1999
<i>Quadrula asperata</i>					6	3
<i>Lampsilis omata</i>					6	1
<i>Lampsilis s. claiibomensis</i>					2	1
<i>Tritogonia verrucosa</i>					4	2
<i>Corbicula fluminea</i>		1			1	
<i>Fusconaia cerina</i>					2	1
<i>Villosa lienosa</i>						
<i>Obovaria jacksoniana</i>						
<i>Obovaria unicolor</i>						
<i>Lampsilis perovalis</i>				1		1
<i>Lampsilis complanata</i>						
<i>Villosa vibex</i>				1		
<i>Pyganodon suborbiculata</i>						
<i>Pyganodon grandis</i>						
<i>Lampsilis teres</i>						
<i>Elliptio arctata</i>					1	
<i>Elliptio crassidens</i>					1	
<i>Leptodea fragilis</i>						
<i>Pleurobema decisum</i>						
<i>Strophitus subvexus</i>						
<i>Toxolasma parva</i>						
<i>Potamilus purpuratus</i>						
<i>Quadrula rumphiana</i>						
Total individuals	0	1	0	2	23	9
Total species	0	1	0	2	8	6
Total time (min)	30	112	0	105	60	90
Total time (hr)	0.5	1.9	0.0	1.8	1.0	1.5
Individuals/min	0.000	0.009	0.000	0.019	0.383	0.100

**Table A3**  
**Summary of 3 Years (1997, 1998, and 1999) of Sampling for Freshwater Bivalves at Sites 5 and 6 on Luxapalila Creek, Mississippi**

Species	Site 5			Site 6		
	1997	1998	1999	1997	1998	1999
<i>Quadrula asperata</i>		2		6	7	22
<i>Lampsilis ornata</i>		1	2		2	6
<i>Lampsilis s. claibornensis</i>				7	6	12
<i>Tritogonia verrucosa</i>			5	3	2	6
<i>Corbicula fluminea</i>						
<i>Fusconaia cerina</i>			1			
<i>Villosa lienosa</i>	1					4
<i>Obovaria jacksoniana</i>					1	
<i>Obovaria unicolor</i>						
<i>Lampsilis perovalis</i>						2
<i>Lampsilis complanata</i>						
<i>Villosa vibex</i>						
<i>Pyganodon suborbiculata</i>						
<i>Pyganodon grandis</i>						
<i>Lampsilis teres</i>						1
<i>Elliptio arctata</i>						
<i>Elliptio crassidens</i>			1			
<i>Leptodea fragilis</i>						
<i>Pleurobema decisum</i>						
<i>Strophitus subvexus</i>						
<i>Toxolasma parva</i>						2
<i>Potamilus purpuratus</i>						
<i>Quadrula rumphiana</i>			1			
Total individuals	1	3	10	16	18	55
Total species	1	2	5	3	5	8
Total time (min)	105	80	90	175	96	90
Total time (hr)	1.8	1.3	1.5	2.9	1.6	1.5
Individuals/min	0.010	0.038	0.111	0.091	0.188	0.611

**Table A4**  
**Summary of 3 Years (1997, 1998, and 1999) of Sampling for Freshwater Bivalves at Sites 7 and 8 on Luxapalila Creek, Mississippi**

Species	Site 7			Site 8		
	97	98	99	97	98	99
<i>Quadrula asperata</i>				2		1
<i>Lampsilis ornata</i>				3		4
<i>Lampsilis s. claibornensis</i>						
<i>Tritogonia verrucosa</i>						
<i>Corbicula fluminea</i>						
<i>Fusconaia cerina</i>						
<i>Villosa lienosa</i>						
<i>Obovaria jacksoniana</i>						
<i>Obovaria unicolor</i>						
<i>Lampsilis perovalis</i>						
<i>Lampsilis complanata</i>						
<i>Villosa vibex</i>						
<i>Pyganodon suborbiculata</i>						
<i>Pyganodon grandis</i>						
<i>Lampsilis teres</i>						
<i>Elliptio arcata</i>		1				
<i>Elliptio crassidens</i>						
<i>Leptodea fragilis</i>						
<i>Pleurobema decisum</i>						
<i>Strophitus subvexus</i>						
<i>Toxolasma parva</i>		1				
<i>Potamilus purpuratus</i>						
<i>Quadrula rumphiana</i>						
Total individuals	0	2	0	5	0	5
Total species	0	2	0	2	0	2
Total time (min)	167	90	90	120	90	90
Total time (hr)	2.8	1.5	1.5	2.0	1.5	1.5
Individuals/min	0.000	0.022	0.000	0.042	0.000	0.056

**Table A5**  
**Summary of 3 Years (1997, 1998, and 1999) of Sampling for Freshwater Bivalves**  
**at Sites 9 and 10 on Luxapalila Creek, Mississippi**

Species	Site 9			Site 10		
	1997	1998	1999	1997	1998	1999
<i>Quadrula asperata</i>				17	2	3
<i>Lampsilis ornata</i>				4	1	2
<i>Lampsilis s. claibornensis</i>	1		2	3	2	
<i>Tritogonia verrucosa</i>	1		3		1	2
<i>Corbicula fluminea</i>		1		5		
<i>Fusconaia cerina</i>	1		1	4		
<i>Villosa lienosa</i>						1
<i>Obovaria jacksoniana</i>				1		
<i>Obovaria unicolor</i>						
<i>Lampsilis perovalis</i>						
<i>Lampsilis complanata</i>						
<i>Villosa vibex</i>						
<i>Pyganodon suborbiculata</i>				1		
<i>Pyganodon grandis</i>				1		
<i>Lampsilis teres</i>				1		
<i>Elliptio arctata</i>					1	
<i>Elliptio crassidens</i>						
<i>Leptodea fragilis</i>						
<i>Pleurobema decisum</i>					1	
<i>Strophitus subvexus</i>						
<i>Toxolasma parva</i>						
<i>Potamilus purpuratus</i>						
<i>Quadrula rumphiana</i>						
Total individuals	3	1	6	37	8	8
Total species	3	1	3	9	6	4
Total time (min)	90	72	90	190	80	90
Total time (hr)	1.5	1.2	1.5	3.2	1.3	1.5
Individuals/min	0.033	0.014	0.067	0.195	0.100	0.089

**Table A6**  
**Summary of 1 Year (1999) of Sampling for Freshwater Bivalves at Sites 10a and 10b on Luxapalila Creek, Mississippi (NS = Not Sampled)**

Species	Site 10a			Site 10b		
	1997	1998	1999	1997	1998	1999
	NS	NS		NS	NS	
<i>Quadrula asperata</i>			5			
<i>Lampsilis ornata</i>						
<i>Lampsilis s. claibomensis</i>			3			
<i>Tritogonia verrucosa</i>			3			
<i>Corbicula fluminea</i>						
<i>Fusconaia cerina</i>			1			
<i>Villosa lienosa</i>						
<i>Obovaria jacksoniana</i>						
<i>Obovaria unicolor</i>						
<i>Lampsilis perovalis</i>						
<i>Lampsilis complanata</i>						
<i>Villosa vibex</i>						
<i>Pyganodon suborbiculata</i>						
<i>Pyganodon grandis</i>						
<i>Lampsilis teres</i>						
<i>Elliptio arctata</i>			1			
<i>Elliptio crassidens</i>			1			
<i>Leptodea fragilis</i>						
<i>Pleurobema decisum</i>			2			
<i>Strophitus subvexus</i>						
<i>Toxolasma parva</i>						
<i>Potamilus purpuratus</i>						
<i>Quadrula rumphiana</i>						
Total individuals	0	0	16	0	0	0
Total species	0	0	7	0	0	0
Total time (min)	0	0	45	0	0	45
Total time (hr)	0.0	0.0	0.8	0.0	0.0	0.8
Individuals/min	0.000	0.000	0.356	0.000	0.000	0.000

**Table A7**  
**Summary of 2 Years (1998 and 1999) of Sampling for Freshwater**  
**Bivalves at Site 11 on Luxapalila Creek, Mississippi (NS = Not Sampled)**

Species	Site 11		
	97	98	99
	NS		
<i>Quadrula asperata</i>			
<i>Lampsilis omata</i>			
<i>Lampsilis s. claibornensis</i>			
<i>Tritogonia verrucosa</i>			
<i>Corbicula fluminea</i>			
<i>Fusconaia cerina</i>			
<i>Villosa lienosa</i>			
<i>Obovaria jacksoniana</i>			
<i>Obovaria unicolor</i>			
<i>Lampsilis perovalis</i>			
<i>Lampsilis complanata</i>			
<i>Villosa vibex</i>			
<i>Pyganodon suborbiculata</i>			
<i>Pyganodon grandis</i>			
<i>Lampsilis teres</i>			
<i>Elliptio arctata</i>			
<i>Elliptio crassidens</i>			
<i>Leptodea fragilis</i>			
<i>Pleurobema decisum</i>			
<i>Strophitus subvexus</i>			
<i>Toxolasma parva</i>			
<i>Potamilus purpuratus</i>			
<i>Quadrula rumphiana</i>			
Total individuals	0	0	0
Total species	0	1	0
Total time (min)	0	80	30
Total time (hr)	0.0	1.3	0.5
Individuals/min	0.000	0.000	0.000

